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Artificial lawns: environmental and societal considerations of an ecological simulacrum

Abstract

The replacement of living lawns with synthetic (plastic) grass seems to be on the increase in cities. This paper presents some environmental and societal considerations relating to the installation of artificial lawns to encourage research of the phenomenon at this early stage of emergence. After first discussing the development of 'third generation' synthetic grasses that have made artificial lawns more appealing, it then considers how the replacement of living lawns with plastic grass represents a potentially concerning step towards ecological simulation, or the replacement of real ecosystems with simulacra that address cultural desires but remove nature altogether. The paper then examines some of the possible environmental and societal impacts that may result from the replacement of living lawns with their artificial counterparts, and concludes with the presentation of a research framework for investigation of the emerging artificial urban lawnscape.

Word count: 3970 (main text and references)

Keywords

Plastic; turf; polymer; simulacrum; simulacra; simulation; synthetic; status theory; lawn

Introduction

Lawns are common throughout cities in the Global North, particularly in North America, Europe and Australasia. They are part of western culture, embedded in the fabric of settlements large and small and central to everyday domestic space (Trudgill et al., 2010; Robbins, 2012). Residences, places of work, public venues and facilities, sports and recreational grounds and schools around the world maintain lawns. They have not appeared by chance; like buildings, they have been intentionally constructed, propagated, and replicated globally. Particularly prevalent in cities, lawns comprise a substantial proportion of residential gardens (or 'yards'), and are extensive in both area and distribution. Robbins and Birkenholtz (2003) estimated that the 'lawnscape' of Franklin County (OH) covered around 23% of the land cover, while Ignatieva et al. (2015) suggest that lawns typically represent 70-75% of urban green space. In Sweden, Hedblom et al. (2017) found an average of 22.5% lawn cover across three cities, with an estimated 2589 km^2 of urban lawns for the country.

Meyer et al. (2001) estimated over 3500 km^2 of lawns in Minnesota, or about 1.5% of the entire state. In the UK, the totality of lawn area exceeds that of London (Davies et al., 2009), while in the US, estimates of lawn area were around 102,000 km^2 in 1993 (Bormann et al., 2001) and c.164,000 km^2 in 2005 (Milesi et al., 2005). Despite their everyday mundanity, they are an important and largely overlooked element of modern life for millions of people.

The replacement of grass lawns with artificial lawns constructed from synthetic polymers (plastics) appears to be on the rise; trends remain unquantified but there are over 100 companies that sell artificial grass online in the UK alone, and it is available to purchase at many hardware stores; Artificial-lawn.co.uk (2017) lists 28 artificial lawn suppliers for the UK and Ireland, and 65 globally. The product is diversifying, with one company listing nine different types of artificial grass, varying in materials, length and colour (Trulawn, 2017). This is indicative of a significant and developing market for artificial lawns. The environmental and societal implications of this remain unknown at the present time, as little published research is available on plastic grass and synthetic turf. This paper summarises the development of the latest 'third generation' of artificial turf before briefly exploring two important elements of the installation of artificial lawn in place of grass lawns in cities: (1) the act as a representation of the ultimate replacement of nature with ecological simulacra, which satisfy cultural expectations of an ecosystem but act in opposition to ecology; and (2) the potential environmental and societal impacts of artificial lawns that need to be explored, particularly in an urban context. It concludes with a suggested framework for further research on artificial lawns in cities.

Plastic grass and artificial lawns

Plastic grass (often termed 'artificial' or 'synthetic' turf) was originally developed in the 1960s for recreational purposes, as a reliable and easy to manage alternative to grass playing fields that could be installed both indoors and outdoors. Early forms (first generation) were scratchy and unattractive, formed primarily of short, stiff nylon or polypropylene (PP) fibres (Stanitski et al., 1974) and with a reflective surface that advertised artificiality. Second generation synthetic turfs held longer fibres interspersed with filler materials such as sand, and looked more like 'natural' playing fields, but were still relatively unrealistic terms of softness and overall aesthetic; their use was primarily confined to sports pitches and playing fields, as for the first generation plastic grasses. Most scientific evaluations of these media have focused on human health implications, either from chemicals contained in the synthetic lawn materials (Zhang et al., 2008), or in relation to sports injuries (Stanitski et al., 1974; Meyers and Barnhill, 2004).

Recent technological developments and the emergence of the ‘third generation’ of synthetic grasses have meant that artificial turfs are now more frequently manufactured from polyethylene (PE) strands surrounded by infill of sand and rubber grains. This sits atop an expanded polypropylene (PP) thatch, with a latex underside. These materials are softer and closer in feel to natural grass, as well as looking more realistic when appropriately manufactured. This has increased the appeal beyond the primary use for sports facilities to more widespread residential and commercial use, in particular for the replacement of lawns. The technology is designed specifically to appeal to the cultural norms associated with lawns: Smith (2016) notes that the lawn realises its ‘highest level of ornamental perfection as a height-managed grass monoculture; a construct that requires frequent mowing and considerable ongoing maintenance if it is to be kept verdant and both weed- and pest-free’ (p. 108). Weigert (1994) presents a ‘status theory’ of lawns wherein ‘good’ lawns are associated with particular characteristics (Weigert, 1994), including the dominance of grasses and an absence of herbaceous species (‘weeds’), softness of the grass (tactility), rich green colour (suggesting health, rather than an ‘unhealthy’ brown), density of sward, intensive management (a good lawn takes effort and investment), neatness (short, manicured grasses are best) and consistency (uniformity of appearance, based on the above, is good; heterogeneity is bad). A plastic lawn is designed specifically to satisfy the cultural demands of a ‘good’ lawn, addressing the ‘semiotics of appearances’ (Weigert, 1994, p. 83) in exemplary fashion, meeting the desired criteria whilst removing the requirement for intensive management. The potential appeal of such constructs is clear.

Artificial lawns as ecological simulacra

Artificial lawns meet the cultural requirements of ‘good’ lawns. Yet they do so at the expense of any remaining ‘naturalness’ and embodiment of life. They present a *simulacrum* (*sensu* Baudrillard, 1994) of the desired ecosystem, a stylised representation of an ecosystem that people can utilise while bypassing the need to acknowledge or interact with other species entirely. The ecosystem has been exchanged for its simulated ‘form’, and the ecological foundation is merely illusory. Artificial lawns support no birds, no bees, no ants, release no pollen; contain no life, other than perhaps microorganisms that need to be cleaned off. In this sense, the artificial lawn is a true simulacrum in all nuances of the term; as a representation of something (immediately, a lawn, and at further remove an open grassland or forest glade) and an unsatisfactory or specious imitation (OED, 2017); and in Baudrillard's (1994) terms, an embodiment of a simulation, an attempt to 'feign what one doesn't have' (p. 3). Contrary to appearances, one has dead, sterile turf, not a living lawn.

Indeed, the synthetic lawn meets the cultural expectations of a 'good' lawn more effectively than a real lawn ever could, and therefore in essence may be, or may become, what Baudrillard (1994) terms a 'pure simulacrum' (p. 6), having no basis in reality – plastic grass is really not grass at all – and ultimately leading to the 'reversion and death sentence of [the] reference' [in this case a living lawn] (p. 6), should synthetic lawns ultimately replace real lawn ecosystems. It may therefore be that artificial lawns are an example of ecological hyperreality, and thereby demonstrate the 'disappearance of objects [living lawns] in their very representation' (Baudrillard, 1994, p. 45).

The emergence of ecological simulacra is not necessarily tied to artificial lawns alone, and technological developments have created possibilities in other areas. Certainly there are synthetic plastic trees and wall coverings available from some of the same companies that manufacture artificial turf, and which may be adopted for similar reasons in domestic space. Yet it is not just plants that lend themselves to simulation. Rault (2015) has suggested that simulacra of domestic pets, in the form of robotic or virtual animals, may become increasingly common. In this case, as for lawns, the cultural values of the species, or at least its domesticated form, are simulated and reinforced whilst removing the species entirely. As children have been observed to treat robotic pets in the same ways as living dogs (Melson et al., 2009) and given that such simulacra 'can without doubt trigger human emotions' (Rault, 2015, p. 3), cultural propagation of artificial pets also seems an intriguing possibility. As technology advances and the simulacra become more realistic it is likely to become more appealing and hence more common, raising further possibilities for hyperreality (Baudrillard, 1994) in human-nonhuman interactions. Nonetheless, artificial lawns represent an intriguing case study that has the potential to become common in cities and therefore deserves the attention of urban ecologists in particular.

Perhaps such lawn replacement is not of immediate concern; artificial lawns must currently represent only a tiny proportion of private green space. Yet there are important implications to be considered if replacement becomes increasing popular and widespread, ranging from environmental to social. These are now explored in more detail.

Environmental considerations of artificial lawns

The environmental limitations of *real* lawns have become increasingly apparent in recent decades, and have been discussed elsewhere (e.g. Ignatieva et al., 2015). Key detrimental aspects of lawns include sustained addition of chemicals such as herbicides, pesticides and fertilisers (e.g. Robbins and Birkenholtz, 2003), generally (though not universally) low biodiversity due to poor-quality habitat and dominance of a few grass species (Thompson et al., 2004), abundance of non-native and potentially invasive species (Stewart et al. 2009) and release of nitrous oxide (N_2O) and methane (CH_4) if irrigated and fertilised (Livesley et al., 2010). Factors such as area and management are important for determining many of these impacts (Cameron et al., 2012). For example, lawns are one of the few ecosystems that in some cases may display a negative species-area relationship, meaning that as lawn area increases, the number of species found may decline, rather than increasing as is the almost universal trend (Stewart et al., 2009). This is because management of larger lawns favours more intense mowing and weeding that restricts spontaneous herbaceous growth, and is particularly the case for large public (e.g. park) lawns, as opposed to private lawns, which maintain more usual (positive) species-area relationships and more variable management practices (Thompson et al., 2004).

Lawns do provide some useful ecosystem services however, as reviewed by Beard and Green (1994); particularly in urban areas, where the alternatives are often impermeable surfaces such as concrete. Alongside the more obvious cultural services of recreation, aesthetics and wellbeing, lawns may provide regulating services such as allowing rain infiltration, thereby limiting surface runoff associated with flash floods (Ignatieva et al., 2015) as well as sequestering carbon (Qian and Follett, 2002) and helping to moderate urban heat island effects (Beard and Green, 1994). Supporting services such as species habitat and providing resources for pollinators may also be associated with lawns (Thompson et al., 2004), though of course the quality and level of provision is relative.

Advocates of artificial (synthetic) lawns often cite their environmental benefits in comparison to traditional lawns, with plastic grass needing no watering, no mowing (thereby saving energy), no application of fertilisers and pesticides, and reduced allergenic health and lifestyle impacts, as no pollen is released (Cheng et al., 2014). In effect, wider environmental impacts on water and energy may be reduced at the expense of more localised impacts on the environment of the lawn space itself. It seems clear that impacts will result to local biodiversity from the replacement of grass with plastic, including loss of habitat; but other, more enigmatic impacts are likely to occur at both local and broader scales yet remain to be quantified.

It seems likely that most ecosystem services will be degraded by the replacement of real lawn with artificial lawn, with perhaps the exception of some cultural services, and reduction of some disservices such as the spread of invasive alien species (summarised in Table 1). Impacts on soil respiration and soil organisms remain unknown, other than a single study into the responses of earthworms and microbes to chemicals associated with the rubber infill crumb (Pochron et al., 2017). The sand and rubber infill, as well as the synthetic polymers of the grass itself, are also subject to erosion and can thereby enter drainage networks, potentially contributing to ongoing water quality issues (Cheng et al., 2014). Carbon sequestration is likely to be reduced, while rain infiltration rates may be lower and run-off increased. Such impacts may have relatively little import at fine scales but, as is the case for the benefits of (for example) wildlife gardens, which accrue at the landscape scale, widespread uptake of artificial lawns will have a cumulative effect on the environment.

Societal considerations of artificial lawns

Other implications of the emergence and uptake of artificial lawns may be profound, and realised over generations. Miller (2005) highlights the 'extinction of experience', wherein the increasing estrangement of people from the more natural world, especially in cities, means that the habitus (societal norms that influence individual thought and behaviour; Bordieu, 2005) acquired by an individual within a given generation, particularly through childhood experiences, will be conditioned by an ecologically impoverished environment; consequently the baseline of 'normal' ecological quality is lowered, and expectations are eroded generationally. If the synthetic lawn simulacrum becomes 'normal' or attains societal equivalency to other lawn types, this may be a further shift towards lower expectations of nonhuman life in domestic space; a trend at odds to the need to bring biodiversity back into the city (e.g. Francis and Lorimer, 2011).

The tendency to for artificial lawn installation may propagate socially in various ways. Of particular concern is the tendency for mimicry of garden (and lawn) design and form at the neighbourhood scale (Hunter and Brown, 2012; Minor et al., 2016). Minor et al. (2016) note that structural vegetation heterogeneity was the most mimicked aspect of gardens in a study in Chicago (IL), probably because residents who felt pressurised to maintain an attractive and conformist garden (and therefore confirm to Weigert's (1994) status theory), but who had limited time to dedicate to such activities, would replicate the essential structural characteristics of neighbouring gardens (lawn, flowerbeds, trees), but in ways that minimise management efforts; a process exacerbated by lack of knowledge or interest in the ecological benefits of less regulated gardens. It is not difficult to appreciate how societal pressures and cultural norms might lead to neighbourhood-scale mimicry of artificial lawns given their satisfaction of the social norms associated with ‘good’ and therefore high-status lawns, along with their lower maintenance requirements and advertised environmental benefits. Indeed, the main attractions of artificial lawns are that they conform to the social norms of lawn appearance but require less time and energy to maintain; attributes that may particularly appeal to both older members of society, who may not wish to invest in lawn upkeep but are perhaps most likely to own private gardens and lawns (McKee, 2012), as well as younger generations who may be too stressed and busy to worry about lawn management. For these sectors of society in particular, such simulacra may represent a culturally meaningful solution to the problem of how to maintain status without sacrificing time and effort.

Yet synthetic grass does not address all cultural aspects of the lawn, especially those not as explicitly recognised as the look and feel of grass. Though haptic and visual experiences on artificial lawns may be satisfactory, olfactory and auditory cues are more limited or missing; both of which play a role in the wellbeing benefits that accrue from exposure to nature (Rhind, 2014; Hedblom et al., 2017). Indeed, plastic grass needs cleaning to ensure that it doesn’t present an unpleasant odour once ‘contaminated’ by nature, whether through detritus blown in by the wind, or from domestic animals. Outside of the immediate materiality of the synthetic grass, the lack of ‘life’ associated with artificial lawns may also compromise their recreational utility, at least in the sense of engaging with the outdoors. In most cases the artificial lawn will be situated within a wider garden space, containing plants and soils that will support at least transitory use by animals; but in cases where artificial lawns are larger or in the absence of a garden context, the ‘soft fascination’ (Cerwén et al., 2016) of nature may become further removed, the lawn user distanced. Consequently, the ‘sensuous and embodied experiences’ (Bhatti et al., 2009, p. 61) found in the garden are unavoidably limited if the sensual stimuli are curtailed.

These considerations remain largely unquantified however, and any rigorous exploration of artificial lawns needs to consider social and environmental drivers and impacts. This paper now presents a framework to develop this area of research.

A framework for investigation of the artificial lawnscape

In a recent paper, Ignatieva et al. (2015) outlined a framework for transdisciplinary investigation of lawns. Here, it is suggested that a similar approach is needed to establish the uptake and both environmental and social impacts of artificial lawns in cities at this relatively early stage of emergence.

Figure 1 shows a research framework for exploring the status of artificial lawnscapes in cities, which would require mixed method approaches that combine social and environmental sciences. Potential areas for investigation within these components, and the possible methods utilised, are suggested in Table 2. This research framework and focus on highlighted areas would allow the hypothesised changes to ecosystem services suggested in Table 1 to be proved or disproved. The lawnscape 'status' may be regarded as the spatial distribution of artificial lawns as well as their physical and ecological characteristics such as size, age, condition, and so on.

Other components of the framework are:

- *Social and economic drivers*: These are the socioeconomic variables that may relate to artificial lawn installation, such as patterns of income, home ownership, spatial demographics and so on.
- *Cultural context*: This is important for any given city, as cities that do not contain much private green space, or have a history of domestic lawn creation and management, are less likely to experience installation of artificial lawns and will provide useful caveats for comparative studies between cities.
- *Maintenance and management*: Though artificial lawns are relatively low maintenance, they may need periodic cleaning or maintenance and this may influence both uptake and lawn condition, as well as potential environmental impacts.
- *Societal impacts*: These include potential changes to how the lawn is used by people, how their experience of the lawn varies and may influence personal wellbeing, how their perception of lawn (and nature) may change and so on; and so whether cultural ecosystem services may increase or decrease.
- *Environmental impacts*: These are likely to cross many ecological aspects including soils, hydrology, microclimate, biota and pollution, and will help determine in particular how regulating and supporting ecosystem services may (or may not) be impacted.

Adoption of such a research framework should help to quantify the spatial emergence and impacts of the artificial lawnscape in cities, and ideally would consist of investigations across multiple spatial and temporal scales. These would examine patterns, trends and impacts (1) between different sub-city urban areas, for example looking at how environmental and social variables influence the artificial lawnscape in different districts, and the extent to which ecosystem services are impacted; and (2) between different urban regions, comparing cities with different environmental, cultural and developmental contexts. Such investigations would provide much-needed information on the societal and environmental implications of lawns as ecological simulacra, as well as ways to manage or mitigate any potential problems.

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Figure caption:

Figure 1: Research framework for examining the status of the artificial lawnscape in cities. See text and Table 2 for further elaboration.

Tables:

Lawn ecosystem service	Likely change when replaced by artificial lawn*
Regulating	
Infiltration and runoff reduction	-
Carbon storage and sequestration	-
Pollutant removal (air and water)	-
Temperate microclimate (temperature regulation)	-
Supporting	
Habitat	-
Pollination	-
Soil stabilisation	-
Nutrient cycling	-
Cultural	
Recreation	+/-
Aesthetics	+/-
Personal wellbeing	+/-
Ecosystem disservice	
Pollution from herbicides, pesticides and fertilisers	-
Release of N_2O and CH_4	-
Establishment and spread of IAS	-
Release of allergens (pollen)	-

Table 1: A selection of ecosystem services and disservices typically associated with lawns and their likely change when replaced by artificial lawns. Provisioning services are not associated with lawns. Regulating and supporting services are likely to decrease, while cultural services may increase or decrease, depending on how artificial lawns are used and experienced. Ecosystem disservices associated with lawns are generally reduced or negated. *symbols are as follows: + increase, - decrease, +/- potential increase or decrease.

Research framework components and potential areas of investigation	Potential methods of investigation
Artificial lawnscape status	
Landscape area and distribution, density, patch size, proximity	Landscape metrics; remote sensing (synthetic turf should be detectable using infrared bands); GIS; field measurements
Patch age (time since installation)	Remote sensing of temporal change, stakeholder interviews
Patch condition/quality (damage to material, cleanliness)	Field measurements, stakeholder interviews
Social and economic drivers	
Household and disposable income	Secondary data analysis (e.g. govt, census data)
Home ownership	Secondary data analysis (e.g. govt, census data)
Age demographics	Secondary data analysis (e.g. govt, census data)
House and plot/garden size	Remote sensing; field measurements
Lawn mimicry between neighbours	Remote sensing; field measurements; stakeholder interviews
Cultural context	
History of urban land use and green space	Desk study; archival analysis; stakeholder interviews
Geographical region (variation within/between cities and countries)	Desk study of regional variations in development and culture
Maintenance and management	
Frequency of cleaning/repair/replacement	Stakeholder interviews
Cost of maintenance	Stakeholder interviews
Societal impacts	
Amenity and recreational use	Stakeholder interviews
Perceptions and expectations of lawns	Stakeholder interviews
Influence on social status	Stakeholder interviews
Personal wellbeing	Stakeholder interviews
Environmental impacts	
Soil condition	Field measurements; lab experiments
Soil biota	Field measurements; lab experiments
Species behaviour and interactions	Field measurements
Habitat and biodiversity	Field measurements
Pollutant storage and release	Field measurements
Carbon storage and sequestration	Field measurements; lab experiments; modelling
Infiltration and runoff	Field measurements; lab experiments; modelling
Surface temperature	Field measurements; remote sensing

Table 2: Potential areas of research investigation within each component of the suggested research framework given in Figure 1, and relevant methods that may be applied.

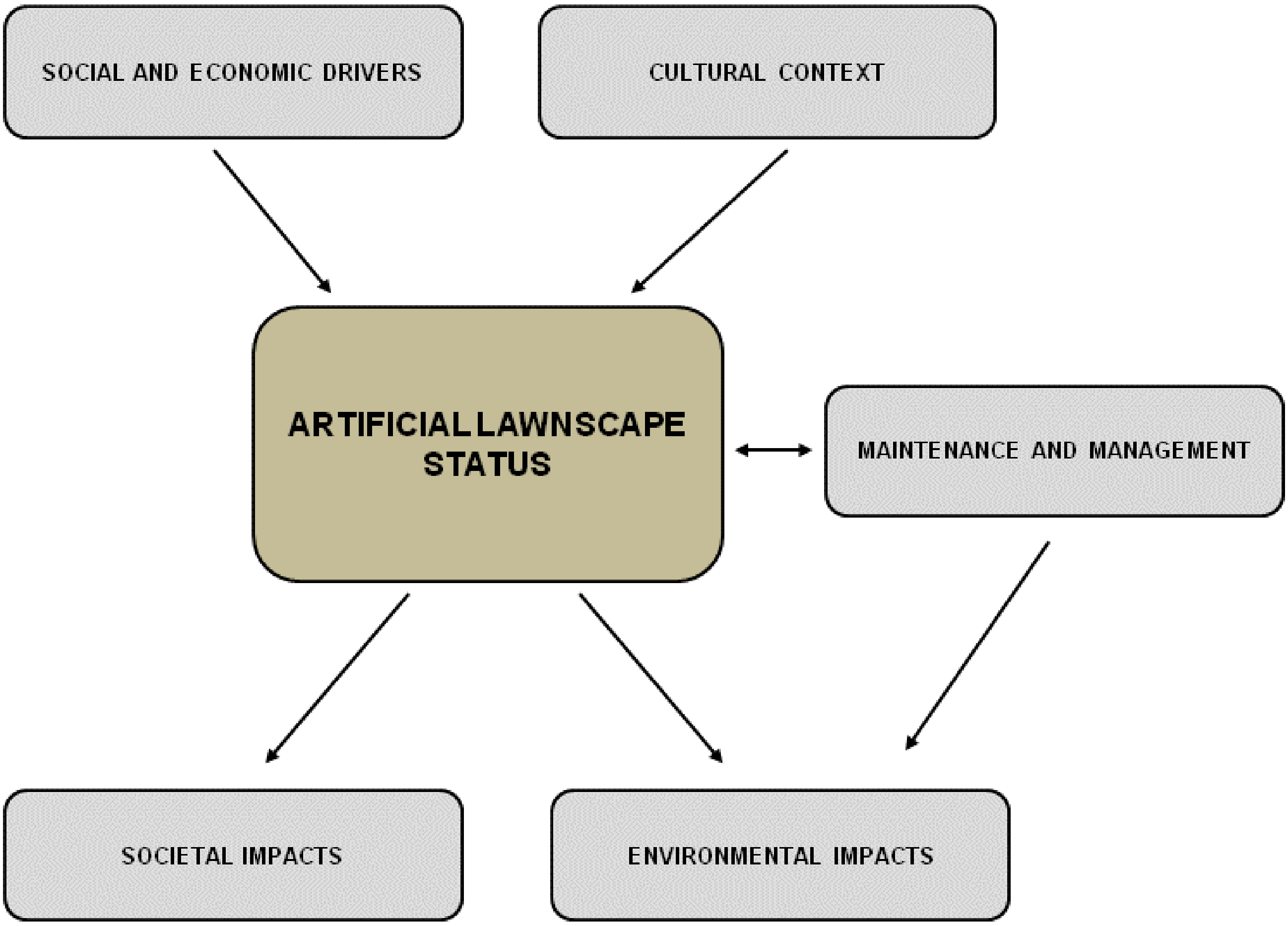

Figure 1: Research framework for examining the status of the artificial lawnscape in cities. See text and Table 2 for further elaboration.